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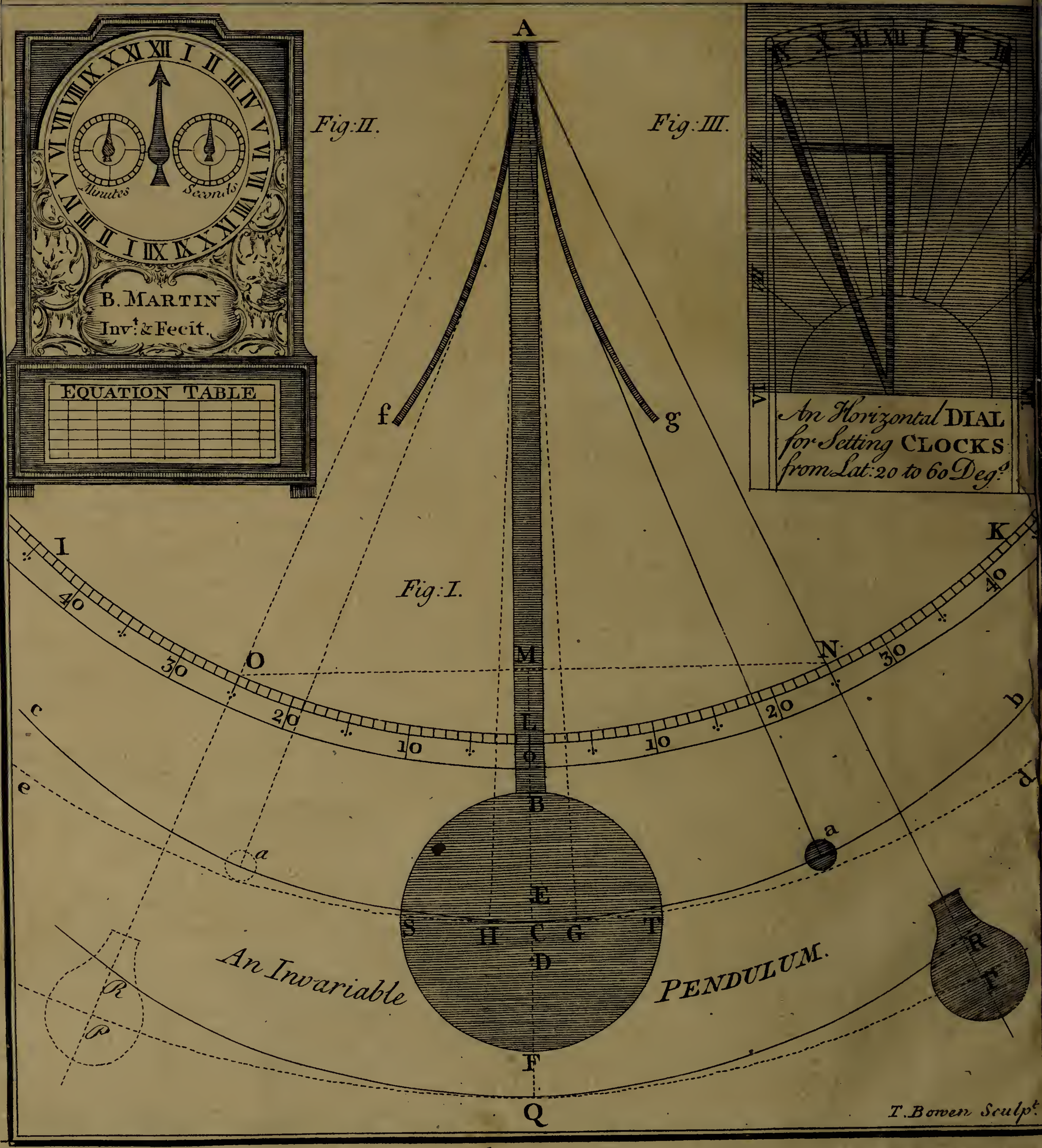
(see p 7)

A TABLE CLOCK on a New CONSTRUCTION; going by a WEIGHT 8 Days; with a Half-Second PENDULUM, of an Invariable Length; shewing HOURS, MINUTES, & HALF-SECONDS by New & most simple Machinery.

Invented made & sold by B. MARTIN. LONDON.



T. Bowen Sculp.t

THE

DESCRIPTION and USE

OF A

TABLE-CLOCK

UPON A

NEW CONSTRUCTION,

Going by a WEIGHT Eight Days; with a Half-Second PENDULUM of an *invariable* LENGTH, and thereby dividing TIME into HOURS, MINUTES and HALF-SECONDS, with all the Accuracy poſſible.

WITH

An Account of the particular PRINCIPLES, derived from NATURE and ART, upon which this new MECHANISM depends.

By B. MARTIN.

Invented, made, and ſold by the AUTHOR, in Fleet-Street, No. 171.

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THE

DESCRIPTION and USE

OF A

TABLE-CLOCK

UPON A

NEW CONSTRUCTION.

IT is preſumed that every one who pretends to any Skill in Clock-Work, muſt neceſſarily know, that all the Truth of ſuch Time-Pieces depends upon, and reſults from, the three following general PRINCIPLES: (1.) The *equable* and *uniform Tenor* of Force in the *Primum Mobile,* or Firſt Mover, which is either a WEIGHT or a SPRING. (2.) The *free and natural Action* of that part which governs and regulates the Motion in Clocks and Watches, and cauſes them to divide Time as equably as poſſible. This is done by a PENDULUM or *Ballance-Wheel.* (3.) The Goodneſs and Truth of the Work of the Wheels and Pinions in the BODY or TRAIN of the CLOCK.

Now the Reaſon on which I ground my *new* PLAN or CONSTRUCTION of a TABLE-CLOCK, is owing to the Obſervations I have

I have long made on the Defects of the common Sort of *Table-Clocks* in every one of the above recited *eſſential* Particulars. For, in the firſt Place, every *Clock-Maker* muſt allow that the Action of a WEIGHT is the *only Principle* for generating equable Motion that Nature affords, at leaſt much more ſo than a SPRING and FUSEE can be, though it has not been as yet applied to Table-Clocks. In the ſecond Eſſential, the PENDULUM, I ſhall be more particular in it's Defects in common Clocks by and by; and ſhall only ſay, with Regard to the TRAIN of Clocks, as they are uſually made, it is very different from that in mine.

In the new Conſtruction *of the Table-Clocks* I here propoſe, it is neceſſary then that they ſhould go by a WEIGHT; and that this Weight ſhould not exceed what is required to actuate the Pendulum in a proper Degree, and accordingly it is adjuſted to anſwer that Purpoſe adequately.

In the the next Place, the Train of Wheel-Work in theſe Clocks is quite of a *new Form*; for, as they ſhew the Time in *Half-Seconds*, the *Hour*, *Minute*, and *Second Hands* are all upon ſeparate Axles, and independent of each other, there being nothing of that *Intercalary Work* between the Dial-Plate and Body of the Clock, as in all others; and by this Means the Syſtem of Wheels and Pinions is undoubtedly rendered the moſt ſimple and perfect that this Sort of Mechaniſm will admit of.

Further, a new Calculation for the Train in general, and quite a new Form for the *Swing-Wheel* became neceſſary, inaſmuch as this Wheel immediately acts upon the Pendulum, and not only communicates to it the requiſite Impulſe, but likewiſe determines the *Arch* of *Oſcillation* or *Vibration*, upon which the *Truth of Clock-Work* ſo much depends.

In order to make this important Article of the PENDULUM as plain as may be, I ſhall here explain it's principal Properties by a Figure in the *Frontiſpiece*. Let (a) be a heavy Ball, ſuſpended upon the String (A a) from the Axle, or Center A, on which it is ſuppoſed to move with the utmoſt Freedom. Then if this

Ball

Ball were brought to the Point (a), and there let go, it would deſcend and vibrate through an Arch (a *a*), biſected in the Point C by the perpendicular Line A Q.

But this Arch or Extent of Vibration will very ſenſibly leſſen, and in a few Minutes be reduced to the ſmall Arch G H, of about *Half an Inch* in Length, in which the Pendulum will continue to oſcillate for a conſiderable Time, 'till this alſo gradually decreaſing, the Ball or Pendulum will at length be reduced to reſt in the loweſt Point C.

Now the Pendulum is reduced to reſt by the Action or *Reſiſtance* of the *Medium,* Axle, &c. From hence it appears that a Force muſt be derived from the *Primum Mobile,* or Weight, through the Train of the Clock, and impreſſed on the Pendulum, that ſhall be a little ſuperior to the retarding Forces of Reſiſtance, that ſo the Clock may be conſtantly kept in Motion.

Since all the Truth of a Clock depends upon an *exact Equality* in the Times of Vibrations of the Pendulum, and theſe Times can never be equal but when the Pendulum moves in the Arch of that particular Curve (b c), which is called a *Cycloid,* and that muſt be effected by making the String of the Pendulum apply itſelf to the two inverted Parts of the ſame Curve A f, A g, (called *cycloidal Cheeks)* therefore it will follow that no Pendulum, left to itſelf, *can oſcillate in equal Times;* as, in that Caſe, it muſt deſcribe the Arch of a Circle (d e.)

But ſince the Cycloid (b c) and the Circle (d e) do both paſs through the Point C; and that therefore they muſt nearly coincide for a ſmall Space on either Side, as from C to G and H; conſequently, if the Pendulum vibrates through a very ſmall Arch G H, of about 3 or 4 Degrees, or ½ an Inch, it may be deemed as vibrating in the *Cycloid* (b c), and therefore in *equal Times.* Hence the Reaſon why the Pendulums of theſe new Clocks oſcillate through ſo ſmall an Arch as ½ an Inch, or ¾ at moſt.

Whereas in the common Clocks the Pendulum P is often obſerved to ſwing through an Arch of a Circle P *P* of 4, 5, and 6 Inches Length; and therefore far enough different from the *Cycloid* R *R* through the ſame Point Q. Hence it muſt be eaſily ſeen, how far ſuch Pendulums muſt be from any Diſpoſition to vibrate in equal Time, and that they never can go true but by Violence and unnatural Methods; for, as I obſerved, no Pendulum does naturally *vibrate* in a large Arch; the continued large Oſcillations of Pendulums, therefore, in common Clocks muſt proceed from the too great Force or violent Action of the Spring.

It is alſo well known, that for a Pendulum to vibrate in a *given Time* it muſt be of a *given Length*: By the Length of the Pendulum is meant the Diſtance between the *Center of Motion* and of *Oſcillation*; but where either of theſe Centers can be found in the common Pendulums of Clocks, there are no Means to diſcover. In the Clocks I make, theſe Centers are truely determined, and conſequently the Length of the Pendulum, by *Mathematical Calculation*.

As the Equability and Truth of the Oſcillation of Pendulums depend on their Length, it is evident, unleſs that Length be conſtant, the equal Motion cannot be ſo. But *metalline Subſtances* of every Kind have their *Lengths variable by* HEAT *and* COLD; conſequently the Rods of the Pendulums for theſe new Clocks *are not to be of Metal*, but of ſuch a Subſtance as will not ſenſibly alter in Length by the *moſt extreme Degrees of Heat and Cold* that any Clock can poſſibly be expoſed to.

Laſtly, the Length of a Pendulum, conſtructed as it ought to be, has alſo a Relation to the Ratio there is between the *Weight of the Rod* A B, the *Weight of the Bob* B S F T, and the Diameter thereof B F: Theſe are therefore moſt ſcrupulouſly to be attended to, and determined by a BALLANCE.

But, that the Whole of this *new Plan of Clock-Work* may appear in one Point of View, I have here connected all the *Eſſentials* as follow: (1.) The Diſtance A C of the Center of the Ball or Bob C from the Center of Motion A. (2.) The Diſtance A D, or A E, of the Center of Oſcillation D or E, from the Center of Motion A. (3.) The Radius B C of the Bob, which in theſe Clocks is a *circular Plane* B S F T. (4.) The Weight of the Bob. (5.) The Weight of the Rod. (6.) The Arch or Chord of Vibration G H or N O. (7.) The peculiar Nature and Subſtance of the Rod. Theſe are all determined with the greateſt Preciſion in theſe new Clocks; but in the Conſtruction of Clocks in the common Way, there is not the leaſt Regard to the due Quantity of any one of them. In ſhort, all that NATURE, by NUMBER, WEIGHT, and MEASURE can impart to Mechaniſm, is here applied to the utmoſt of my Power.

Theſe Clocks go *Eight Days*; and being conſtructed upon ſo natural and perfect a Plan, they merit to be regarded as REGULATORS, by which Watches and other leſs accurate Time-Pieces may be ſet, and by which the niceſt Purpoſes of *Aſtronomical and Chronometrical Obſervations* may be anſwered, as they may be ſtopped at ſo minute and critical a Point of Time as *Half a Second*, which is twice the Exactneſs of the uſual large *Regulators*.

If the Motion of the Clock ſhould at any Time be ſtopped, by forgetting to wind it up, or otherwiſe, it may be ſet by a Dial adjuſted by a magnetical Needle, which is alſo contrived to anſwer that Purpoſe in the beſt Manner, in any Latitude leſs than 60 Degrees; and to that End I have placed in the Clock a Table of the EQUATION of TIME, rectified to the preſent Year 1770, and will ſerve for many Years to come without ſenſible Error.

For aſtronomical Uſes it ſhould be ſet by the Altitude, or equal Altitudes of the Sun; and by Obſervations of the Stars, it may be always made to ſhew the mean Time correctly, as they very well know how to effect, who are concerned in theſe curious Parts of Science, without any Directions from me.

If any Perſon be deſirous of ſeeing a genuine Demonſtration of the Truth of every Thing here advanced, he may be fully ſatisfied by conſulting a Treatiſe intituled *Inſtitutiones Horologicæ*, or *Phyſico-Mathematical* THEORY *of* CLOCK-WORK, which was publiſhed ſome Years ago as a Part of my *Mathematical* INSTITUTES, in 3 Vols. 8vo.

And it may be ſome Satisfaction to the Public to be aſſured, that I have placed the Rods of theſe Pendulums upon a PYROMETER, which magnifies the Extenſion of any Subſtance 3000 Times; and though placed very nigh to a great Fire there appeared no Motion of the Index, which for Metals would have made ſeveral Revolutions with that continued Degree of Heat.

At the ſame Time I kept them in a Glaſs Tube in a *freezing Mixture* (of Salt and Snow,) but could perceive no ſenſible Difference in the Length. The ſame Rods, taken hot from the Fire, were immediately plunged into Spirits of Wine, and after being thoroughly ſaturated with the Liquor, diſcovered no Difference in Length that could affect the niceſt Time-Piece whatever.

Therefore, by ſmall Degrees of Heat and Cold, Moiſture and Dryneſs, the Rods of theſe Pendulums cannot be affected in any ſenſible Degree, nor be productive of the Errors which are common to thoſe of Metal. And therefore what *Hugenius* obſerves of his Clock, whoſe Pendulum oſcillated in the Arch of a Cycloid, may with almoſt equal Truth and Propriety be applied to theſe, viz. *That ſuch a Clock muſt either meaſure Time truely, or not at all.* And I hope it will not be thought preſumptuous to affirm, that *Theſe are the firſt and only Clocks that have been conſtructed with an* INVARIABLE PENDULUM, of a *Half-Second* Length, and put in Motion by a WEIGHT.

There is indeed an Account of a *Pendulum immutable* in Vol. vii. of the *new* COMMENTARIES of the IMPERIAL ACADEMY OF SCIENCES at PETERSBURGH. But when we are told, that it had a *Steel Rod*; and that it would not perform *accurately* but in *one conſtant Temperature of Air*, regulated by a Thermometer, we have no Reaſon to think it could deſerve that Title in the leaſt Degree, but juſt the contrary; for no *metalline* Pendulum was ever yet heard of, that was not of a *mutable* Nature. Beſides, this pretended *immutable Pendulum* was not apply'd to a *Clock*, but to a particular *Chronometer*. And therefore, as it is now near Twenty Years ſince I firſt ſhewed and recommended this truely *invariable Pendulum* in my *public* LECTURES, as the only genuine Regulator of Motion in Clocks, I have no Doubt at all but that the ingenuous Part of the Public will allow my Right to the Invention.

Every Purchaſer of theſe new Clocks may be aſſured that the true and perfect Adjuſtment of the Pendulum, in regard to it's *due* LENGTH *and* WEIGHT, is performed *by my own Hands*; and that the greateſt Care will be taken that the Work, in every other Part, ſhall be good. And, what is moreover quite peculiar to this Conſtruction, is, that the Length of the Pendulum being *invariable*, is to be always truely aſſigned and determined (when required) by a GAUGE.

In the Works of Nature we never fail to admire the moſt evident Simplicity and Congruity of Parts; and in Works of Art, *the more Simple the Mechaniſm, the more perfect the Machine* has been an indiſputable Maxim, and ſcarce ever contradicted but in *Clock-Work*; where, to produce the moſt perfect Time-Piece, we have ſeen the moſt complex, and intricate Mechaniſm employed. But, as the Public has paid pretty well for ſuch abſurd Procedures, I hope the new Conſtruction of a Clock here offered them, as it conſiſts of the leaſt Number of Parts to anſwer ſuch extenſive and accurate Purpoſes, will be favorably received; and no greater Succeſs is deſired than what is proportionable to the Merit of the Machine.

Fig. II. is a View of the Face of the Clock; and Fig. III. of an *horizontal* DIAL for ſetting the Clock by Means of the *Equation Table*; this Dial has *one Requiſite* for this Purpoſe, which is always wanting in common horizontal Dials though ever ſo large; it is beſides applicable to all other Purpoſes of a portable Dial, and will ſerve for all Latitudes from 20 to 60 Degrees.

THE END.

ADVERTISEMENT.

I. *Geographical* Clocks, which ſhew the Motion of the Earth upon it's Axis, and of it's Axis about the Pole of the Ecliptic once in a Year; whereby all the geographical Phænomena of the terreſtrial Syſtem, with Regard to the Poſition of the Earth, Seaſons of the Year, Length of Days and Nights, &c. ariſing from the diurnal and annual Motion of the Earth, are exhibited for every Day, Hour, and Minute throughout the Year, byan artificial Globe kept in conſtant Motion by the Clock.

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